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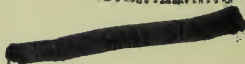
**A GUIDE
FOR
LOCATING LOCOMOTIVE
ENGINE MACHINERY
DEFECTS**

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A GUIDE

For Locating

Locomotive Engine Machinery Defects

Practical Help for Engineers, Firemen
and Machinists, in Setting Forth
the Defects and the Tests
for Defects



BY

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INTRODUCTION.

FROM years of practical experience in the different railroad shops, with different classes of engine machinery, I am offering this little pocket guide to the men who operate and care for the engine machinery, and who desire to know the latest and best methods for locating the defects; setting forth the defects, with the tests for locating the same. The writer has well in mind that much more might be said in regard to the machinery defects, but it is not the intention to show and offer such, but only to show that which will prove beneficial and practical.

— These methods have given satisfaction and it is also suggested that when possible, the method here given be tested out, as we know practice makes perfect.

INDEX

	PAGE
The Valves and Cylinders.....	7
The Driving Gear.....	22
The Running Gear.....	26
To Locate the Valve Strip Blow.....	31
To Locate the Valve Seat Blow.....	33
To Locate the Defective Bridge.....	35
To Locate the Underbalance Valve Blow	37
To Locate the Defective Pressure Plate	39
To Locate both Cylinder Packing Blowing	42
To Locate the inside admission Piston Valve Blow	44
To Locate the Valve Rings Broken..	46
To Locate the Cylinder Packing and the Valve Blowing.....	48
To Locate the Defective Exhaust Ring	50
To Locate the Worn Cylinder Packing.	53
To Locate the Turned Cylinder Bush- ing	56
To Locate the Cylinder Pounds.....	58
To Locate if the Guide Bars need clos- ing or are bent.....	60.

	PAGE
To Locate the Main Rod and Main Box Pounds	60
To Locate the Engine out of tram...	61
To Locate the Loose Wedges and how to adjust same.....	62
The Mallet Engine.....	64
Don'ts	69

THE VALVES AND CYLINDERS.

The superheat engine requires much more attention than the saturated engine. The valve and the cylinder packing rings of the superheat engine require more spring and more opening, for there is a much higher degree of heat in the cylinders. This expands the packing rings more and the spring of the rings is soon destroyed, even if well lubricated.

The piston head should be provided with dowels to prevent the rings from turning around. When the packing rings turn around in the cylinders the rings wear out much faster and are more liable to become broken. The packing rings should be fit with only the opening required for the expansion. If the opening is too large too much steam escapes, which helps to destroy the lubrication and decrease the power.

The slide valve is the most complicated to test, and when overbalanced causes too much friction on the seat, which continually cuts and hollows out the seat, even if well lubricated.

The piston valve packing rings wear smaller and the steam chest bushings wear larger in the middle, where the valves are used most. As a rule, the valves are not used in the extreme position except when the engine is starting or drifting. For this reason the piston valve shows the strongest blow in the central position unless the packing rings are broken, which would then cause the valve to blow in all position.

It should be borne in mind that a slight blow out of the exhaust or the cylinder cock or cocks should not be considered, and when there is a strong blow out of the exhaust, the steam pressure out of the cylinder cock or cocks will be of the same

strong nature as that out of the exhaust, which will indicate the location of the defect.

Fig. 1 shows the slide valve in the central position, with steam lap, line in line, or, in other words, no ex-

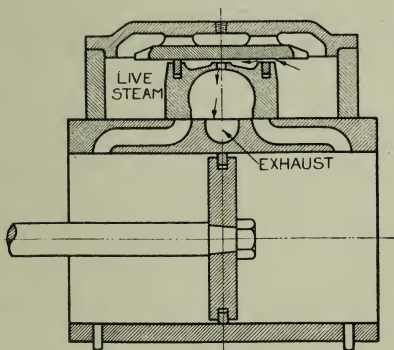


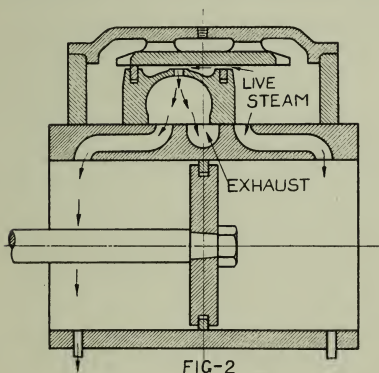
FIG-1

haust clearance. Fig. 1 also shows the defective valve strip, and why there would be a strong blow out of the exhaust and no steam pressure out of the cylinder cocks, even if the valve had exhaust clearance. The blow is so direct into the exhaust

that the steam pressure would be very slight out of the cylinder cocks. The position of the valve will be found as shown in Fig. 1, with either crank on the top or bottom quarter, with the reversing lever in the central position; but in some cases where the valves are out of square, or the reach rod too long or too short, the above would not prove true, so the best method is to move the reversing lever until the valve shuts the steam off from the cylinder. In case the valve seat or the valve rings are leaking, the reversing lever is to be moved until the steam pressure is equal out of the cylinder cocks.

Figure 2 shows the position of the valve with the defective valve strip, with either crank on the bottom quarter and with the reversing lever in the extreme forward position. The front cylinder port is then wide open to live steam and the rear

cylinder port is wide open to the exhaust, showing the blow into the exhaust and out of the back cylinder cock. Then, with the reversing lever in the extreme backward position, the position of the valve would be as



that shown in Fig. 3. Fig. 2 also shows why the defective valve strip shows a stronger steam pressure out of the cylinder cock or cocks when in either of the extreme positions, because the small hole in the top of the valve is then more directly over

the cylinder port, which is open to the exhaust.

Fig. 3 shows the position of the valve with the defective bridge, with either crank on the top quarter and with the reversing lever in the ex-

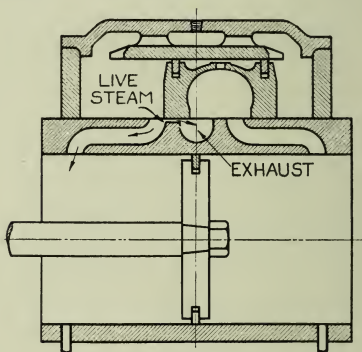


FIG-3

treme forward position. Fig. 3 also shows why there would be a blow out of the exhaust only when the rear cylinder port is opened to live steam. (On the class of engines where the exhaust slobber cocks are found they can be used to some advantage to

locate the defective bridge.) Then with the reversing lever in the extreme backward position, the position of the valve would be as that shown in Fig. 2, and the steam would be shut off from the defective bridge.

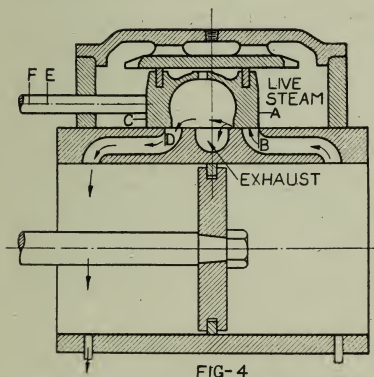
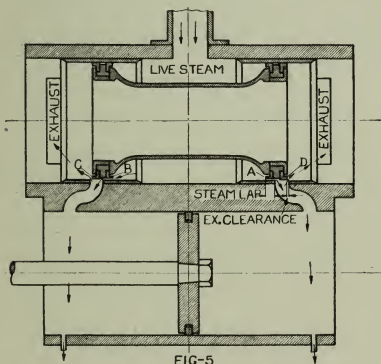


Fig. 4 shows the position of the valve when the front port opening is taken. When point A is at point B, or one sixty-fourth of an inch open, then the valve is in the correct position for scribing the port opening on the valve stem or the valve rod. With

a tram placed at some stationary point, scribe point E on the valve stem. Then move the valve ahead until point C is at point D, or one sixty-fourth of an inch open. The valve is then in the correct position for scribing the rear port opening on the valve stem at point F, and half of the distance between point F and point E will always give the amount that the valve laps beyond each cylinder port, as that shown in Fig. 1. The inside admission piston valve port openings are taken by performing the same operation, only the front port opening would be at point F, and the rear port opening would be at point E. Fig. 4 also shows the position in which the under balanced valve lifts from its seat. After the front cylinder port has been opened wide to live steam and then the valve moved ahead to the point shown, the steam pressure in the cylinder lifts the valve from its seat, which causes a

very strong blow out of the exhaust and the rear cylinder cock.

Fig. 5 shows the inside admission piston valve in the central position with steam lap, exhaust clearance, the admission rings A and B defec-



tive, and shows the steam blowing into the exhaust and out of both cylinder cocks. This position of the valve will be found with either crank on the top or bottom quarter with the reversing lever in the central position. It can be seen from Fig. 1

and Fig. 5 that a valve with steam lap is a valve that laps beyond each cylinder port.

Fig. 6 shows the position of the valve with the admission ring A and the exhaust ring D defective, and

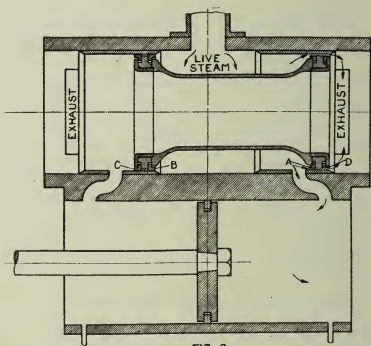


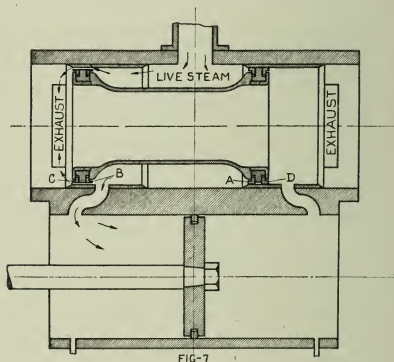
FIG-6

shows the steam blowing into the exhaust. The position of this valve will then be found with either crank on the bottom quarter and with the reversing lever in the extreme forward position. (On the class of engines where the extension valve stem is

used, by slacking off the cap on the front valve ahead, it can be proven that the packing rings A and D are blowing.) Then, with the reversing lever in the extreme backward position, the position of the valve would be as that shown in Fig. 7, and the packing rings A and D would still be blowing into the exhaust and out of the front cylinder cock. It can be found from the position of Fig. 1 and Fig. 6 how to tell the inside admission valve from the outside admission valve, regardless of the design of the engine or the valve gear. The inside admission valve, when either crank is below the center, would move in the same direction as the reversing lever is moved and the outside admission valve would move in the opposite direction. The inside admission valve, when either crank is above the center, would move in the opposite direction from which the reversing lever is moved and the out-

side admission valve would move in the same direction as the reversing lever is moved.

Fig. 7 shows the position of the valve with the admission ring B and the exhaust ring C defective, and the



steam blowing into the exhaust, with either crank on the top quarter and with the reversing lever in the extreme forward position. By slackening off the valve stem gland it can be proven that the rings B and C are blowing. Then, with the reversing

lever in the extreme backward position, the position of the valve will be as that shown in Fig. 6, and the rings B and C would still be blowing into the exhaust and out of the back cylinder cock.

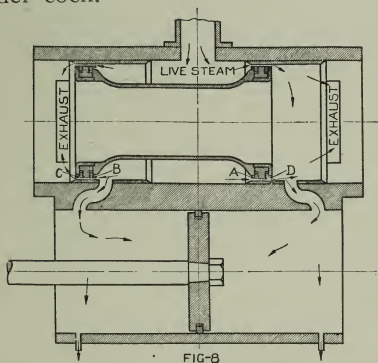
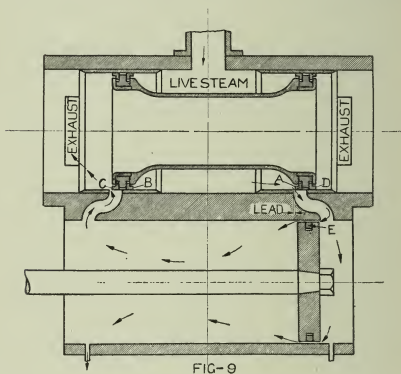


Fig. 8 shows the valve with the defective rings A, B, C, and D, and shows the steam blowing from each end of the valve into the exhaust, which admits the steam into each end of the cylinder at the same time, regardless of the position of the valve.

In this case no one can tell but that the cylinder packing rings are blowing, even though the cylinder packing rings may be steam tight.

Fig. 9 shows the position of the valve with lead, and the cylinder



packing ring E blowing into the exhaust and out of the back cylinder cock. Lead is a valve which opens the cylinder port when the piston is at the end or the beginning of each stroke. The position of the valve remains the same regardless of the po-

sition of the reversing lever, which would cause a constant roar out of the exhaust while testing the opposite side. Then with the crank on either quarter and the reversing lever in the central position the valve and piston would be as shown in Fig. 5. The valve would then shut the steam off from the cylinder.

THE DRIVING GEAR.

It is very important to see that the reach rod is kept the proper length. Plumb the reversing lever, then see if the vertical arm of the lifting shaft is plumb; if plumb, the reach rod is then of the proper length. If the vertical arm of the lifting shaft leans to the right the reach rod is too long; if the vertical arm of the lifting shaft leans to the left, the reach rod is too short and should be adjusted until the vertical arm of the lifting shaft is plumb with the reversing lever.

If the links or reversing yokes are out of the central position when the vertical arm of the lifting shaft is plumb, the vertical arm is not properly set or the gear reach rods are not properly adjusted.

If the reversing lever operates too hard with either crank on the top or bottom quarter, look for the trouble at the bottom end of the reversing

lever or the reach rod connections or the lifting shaft boxes.

If the reversing lever operates too hard only when the right crank is on either quarter, look for the trouble in the right valve gear. If it operates too hard only when the left crank is on either quarter, look for the trouble in the left valve gear.

To find if the lifting shaft boxes should be closed, pry the shaft up and down in its boxes and if the lost motion is over one-eighth of an inch the boxes should be closed or rebushed.

The valve gear should not be allowed to strike any of its parts, and the parts pried up and down, back and forth, to find the badly worn pins and bushings.

When the side play in any part of the valve gear becomes over one-eighth of an inch it causes defects, especially on the baker gear, and should be taken up by using brass washers.

When the lost motion in the valve cross-heads becomes over one-eighth of an inch it causes defective valve stems, and the guides should be closed or the worn parts replaced.

When the valves become out of square they should be squared up, for the engine will not make the time or handle the tonnage, and will burn enough more fuel in one trip to pay for the needed repairs.

When the front end of the cross-head is over one-sixteenth of an inch loose in the front end of the guides, or the back end of the cross-head is over one-sixteenth of an inch loose in the back end of the guides, the guides should then be closed. The side play should also be kept out of the cross-heads.

The brasses at the front end of the main rods should be tried often for pound, and the lost motion should be kept out by keeping the brasses keyed up. The brasses at the back end of

the main rods should be kept keyed up tight in the rod, and when the brasses become over one-sixteenth of an inch larger than the pin the brasses should then be closed. When the side play in the back end of the main rods or side rod bushings become over one-eighth of an inch, it also should be taken up.

THE RUNNING GEAR.

The engine frame should be kept level over the driving boxes and should not be allowed to strike the boxes. Where the engine is low on one side it sometimes causes the flange or flanges to cut on the opposite side. When the driving tire flanges start to cut on either side, the side that is being cut should be lined ahead. The engine truck wheel also, should be lined ahead, when the flange starts to cut. Then one pair of wheels will last as long as three pair under former conditions.

Fig. 10 shows the driver and the position of the right lead engine cranks. When the right crank A is on the forward center the left crank B is on the top quarter. When the engine is moving forward, the right crank A is always in the lead of the left crank B. Then, when the engine is moving backward, the left crank B

is always in the lead of the right crank A. Fig. 10 also shows how to determine the stroke of the piston.

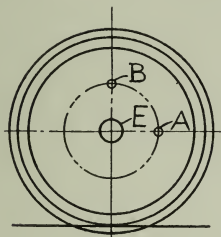


FIG-10

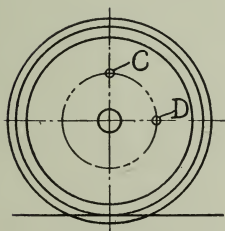


FIG-11

Twice the distance from the center of either crank A or B to the center of the axle E will always give the

stroke of the piston. For example, twice the distance from the center of the crank B to the center of the axle E is two times fourteen and one-half inches, or twenty-nine inches, the stroke of the piston. Fig. 10 explains how the cranks should be placed for testing the right lead engine for valve and cylinder packing defects. For testing the right side the right crank B should be placed on the bottom quarter; then the left crank A will be, as shown on the forward center. For testing the left side, the left crank B should be placed on the top quarter; then the right crank A will be, as shown, on the forward center.

Fig. 11 shows the driver and the position of the left lead engine cranks. When the left crank D is on the forward center the right crank C is on the top quarter. When the engine is moving forward, the left crank D is always in the lead of the right crank C. Then, when the en-

gine is moving backward, the right crank C is always in the lead of the left crank D. Fig. 11 explains how the cranks should be placed for testing the left lead engine for valve and cylinder packing defects. For testing the right side, the right crank C should be placed on the top quarter; then the left crank D will be as shown, on the forward center. For testing the left side, the left crank C should be placed on the bottom quarter; then the right crank D will be as shown, on the forward center.

To find if it is necessary to test the engine for valve and cylinder packing defects, place the crank or cranks in the above mentioned position and move the reversing lever very slowly from one extreme position to the other; then, if a blow is heard out of the exhaust, use the following instructions.

The outside admission piston valve defects, can also be located by per-

forming the same operation, as that used for the slide valve. Of course the engine throttle is to be opened, and the steam leaks of the steam chest and cylinder apparatus, can all be located when the tests are performed.

TO LOCATE THE VALVE STRIP BLOW.

Place the right crank on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. A sharp blow out of the exhaust and the back cylinder cock indicate that the valve is blowing. Place the reversing lever in the central position. A sharp blow out of the exhaust and no steam pressure out of the cylinder cocks indicate that the valve strips are blowing. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the back end of the cylinder. A sharp blow out of the exhaust and the front cylinder cock proves that the right valve strips are blowing.

To prove if the constant blow out of the exhaust all comes from the right side, place the left crank on the

top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. A sharp blow out of the exhaust and no steam pressure out of the front cylinder cock indicate that the cylinder packing is steam tight. Place the reversing lever in the central position. The same blow out of the exhaust and no steam pressure out of the cylinder cocks indicate that the valve is steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. The same blow out of the exhaust and no steam pressure out of the back cylinder cock prove that the left side is steam tight, and that the constant blow out of the exhaust all comes from the right valve strips. See Fig. 1 and Fig. 2 for a strip blow.

TO LOCATE THE VALVE SEAT BLOW.

Place the right crank on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. A shrill blow out of the exhaust and no steam pressure out of the back cylinder cock indicate that the right valve and the right cylinder packing are steam tight. Place the reversing lever in the central position. The same shrill blow out of the exhaust but no steam pressure out of the cylinder cocks prove that the right valve is steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the back end of the cylinder. The same blow out of the exhaust and no steam pressure out of the front cylinder cock prove that the right cylinder packing is steam tight.

Next place the left crank on the top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. A shrill blow out of the exhaust and the front cylinder cock indicates that the left valve is blowing. Place the reversing lever in the central position. A slight blow out of the exhaust and a strong steam pressure out of both cylinder cocks indicate that the valve seat is blowing. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. A shrill blow out of the exhaust and the back cylinder cock proves that the left valve seat is blowing, when the valve is in all positions. It is not necessary to examine the cylinder packing in this case because the sound of the blow did not indicate a cylinder packing blow.

TO LOCATE THE DEFECTIVE BRIDGE.

Place the right crank on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. A roar out of the exhaust and no steam pressure out of the back cylinder cock indicate that the cylinder packing is steam tight. Place the reversing lever in the central position. The same roar out of the exhaust and no steam pressure out of the cylinder cocks prove that the valve is steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the back end of the cylinder. The same roar out of the exhaust and no steam pressure out of the front cylinder cock prove that the right side is steam tight, and that the roar comes from the left side.

Next place the left crank on the

top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. No blow out of the exhaust and no steam pressure out of the front cylinder cock indicate that the left cylinder packing is steam tight. Place the reversing lever in the central position. No blow out of the exhaust and no steam pressure out of the cylinder cocks prove that the valve is steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. A roar out of the exhaust and a slight steam blow out of the back cylinder cock, indicate a defective bridge. There being a blow only when the front cylinder port is open to live steam, prove that the bridge between the front cylinder port and the exhaust is defective. See Fig. 3 for defective bridge.

TO LOCATE THE UNDERBALANCE VALVE BLOW.

Place the right crank on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. No blow out of the exhaust or no steam pressure out of the back cylinder cock indicate that the right cylinder packing is steam tight. Then slowly move the reversing lever toward the central position until a blow is heard. A very strong blow out of the exhaust and a strong steam pressure out of the back cylinder cock indicate that the right valve is blowing. Place the reversing lever in the central position. No blow out of the exhaust or no steam pressure out of the cylinder cocks prove that the valve seat is steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the

back end of the cylinder. No blow out of the exhaust or no steam pressure out of the front cylinder cock prove that the right cylinder packing is steam tight.

Slowly move the reversing lever toward the central position until a blow is heard. A very strong blow out of the exhaust and a strong steam pressure out of the front cylinder cock indicate, from the position of the reversing lever, that the valve has closed the cylinder port and the steam pressure in the cylinder is greater than the steam pressure on the top of the valve. This causes the valve to be lifted from its seat, which causes the blow. By having a blow only when the reversing lever was in the above mentioned positions proves that the valve is not properly balanced.

TO LOCATE THE DEFECTIVE PRESSURE PLATE.

Place the right crank on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. No blow out of the exhaust or no steam pressure out of the back cylinder cock indicate that the right cylinder packing is steam tight. Place the reversing lever in the central position. No blow out of the exhaust or no steam pressure out of the cylinder cocks prove that the right valve is steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the back end of the cylinder. No blow out of the exhaust or no steam pressure out of the front cylinder cock, prove that the right side is steam tight.

Next place the left crank on the top quarter and the reversing lever in

the extreme forward position. The steam is thus admitted into the back end of the cylinder. A very sharp blow out of the exhaust and a strong steam pressure out of the front cylinder cock indicate that the left valve is blowing. Move the reversing lever back three notches and no blow is heard. Place the reversing lever in the central position. No blow out of the exhaust or no steam pressure out of the cylinder cocks prove that the left valve is steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. No blow out of the exhaust or no steam pressure out of the back cylinder cock prove that the left cylinder packing is steam tight.

Having a blow only when the reversing lever was in the extreme forward position indicates that the front end of the pressure plate is defective, or too much travel of the valve, which

caused the blow. If the valve would blow with the reversing lever in both of the extreme positions, it would indicate that the pressure plate was too short, or too much travel of the valve.

TO LOCATE BOTH CYLINDER PACKING BLOWING.

Place the right crank on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. A roar out of the exhaust and a strong steam pressure out of the back cylinder cock indicate that the right cylinder packing is blowing. Place the reversing lever in the central position. A roar out of the exhaust and no steam pressure out of the cylinder cocks prove that the right valve is steam tight, and the roar out of the exhaust comes from the left side.

Then place the reversing lever in the extreme backward position. The steam is thus admitted into the back end of the cylinder. A roar out of the exhaust and a strong steam pressure out of the front cylinder cock prove that the right cylinder packing

is blowing. Next place the left crank on the top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. A roar out of the exhaust and a strong steam pressure out of the front cylinder cock indicate that the left cylinder packing is blowing. Place the reversing lever in the central position. The same blow out of the exhaust and no steam pressure out of the cylinder cocks prove that the left valve is steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. The same roar out of the exhaust and a strong steam pressure out of the back cylinder cock prove that the left cylinder packing is blowing.

TO LOCATE THE INSIDE ADMIS- SION PISTON VALVE BLOW.

Place the right crank on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. A slight blow out of the exhaust and a slight steam pressure out of the back cylinder cock indicate that the right valve is blowing. Place the reversing lever in the central position. A strong blow out of the exhaust and a strong steam pressure out of both cylinder cocks prove that the right valve rings or the steam chest bushings are badly worn, which causes the blow. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the back end of the cylinder. A slight blow out of the exhaust and a slight steam pressure out of the front cylinder cock indicate that the blow comes from the right valve.

Next place the left crank on the top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. A blow out of the exhaust and no steam pressure out of the front cylinder cock indicate that the left cylinder packing is steam tight. Place the reversing lever in the central position. The same blow out of the exhaust and no steam pressure out of the cylinder cocks prove that the left valve is steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. The same blow out of the exhaust and no steam pressure out of the back cylinder cock proves that the left side is steam tight and the constant blow out of the exhaust comes from the right valve.

TO LOCATE THE VALVE RINGS BROKEN.

Place the right crank on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. A roar out of the exhaust and a strong steam pressure out of the back cylinder cock indicate that the right cylinder packing is blowing. Place the reversing lever in the central position. A roar out of the exhaust and a strong steam pressure out of both cylinder cocks prove that the packing rings at both ends of the valve are blowing. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the back end of the cylinder. The same roar out of the exhaust and a strong steam pressure out of the front cylinder cock indicate that the cylinder packing is blowing. In this case, no one can tell

but that the right cylinder packing is blowing too and it should also be examined.

Next place the left crank on the top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. A roar out of the exhaust and no steam pressure out of the front cylinder cock indicate that the left cylinder packing is steam tight. Place the reversing lever in the central position. The same blow out of the exhaust but no steam pressure out of either cylinder cock prove that the left valve rings are steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. The same roar out of the exhaust but no steam pressure out of the back cylinder cock prove that the left cylinder packing is steam tight, and the constant roar out of the exhaust comes from the right side.

TO LOCATE THE CYLINDER PACK- ING AND THE VALVE BLOW- ING.

Place the right crank on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. A roar out of the exhaust and a strong steam pressure out of the back cylinder cock indicate that the right cylinder packing is blowing. Place the reversing lever in the central position. The same roar out of the exhaust and no steam pressure out of either cylinder cock prove that the right valve rings are steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the back end of the cylinder. The same roar out of the exhaust and a strong steam pressure out of the front cylinder cock prove that the right cylinder packing is blowing.

Next place the left crank on the top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. A roar out of the exhaust and a strong steam pressure out of the front cylinder cock indicate that the left cylinder packing is blowing. Place the reversing lever in the central position. The same roar out of the exhaust and a strong steam pressure out of the front cylinder cock, but no steam pressure out of the back cylinder cock, prove that the packing rings at the front end of the left valve are blowing. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. The same roar out of the exhaust and no steam pressure out of the back cylinder cock prove that the left cylinder packing is steam tight, and also that the packing rings at the front end of the left valve are blowing.

TO LOCATE THE DEFECTIVE EXHAUST RING.

Place the right crank on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. A roar out of the exhaust and no steam pressure out of the back cylinder cock indicate that the right cylinder packing is steam tight. Place the reversing lever in the central position. The same roar out of the exhaust and no steam pressure out of either cylinder cock prove that the right valve rings are steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the back end of the cylinder. The same roar out of the exhaust and no steam pressure out of the front cylinder cock prove that the right side is steam tight.

Next place the left crank on the top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. No blow out of the exhaust or no steam pressure out of the front cylinder cock indicate that the left cylinder packing is steam tight. Move the reversing lever slowly to the central position. No blow out of the exhaust or no steam pressure out of either cylinder cock prove that the admission rings and the exhaust ring at the back end of the valve are steam tight. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. No blow out of the exhaust or no steam pressure out of the back cylinder cock prove that the left cylinder packing is steam tight. Move the reversing lever slowly toward the central position until a blow is heard. A roar out of the exhaust and no steam pressure out

of the back cylinder cock indicate that the exhaust ring at the front end of the left valve is blowing. Having a blow out of the exhaust only when the front cylinder port is open, until the valve is moved forward far enough for the admission ring to close the steam off from the exhaust, and no blow is heard, proves that the front exhaust ring is defective.

TO LOCATE THE WORN CYLINDER PACKING.

Place the right crank on the bottom quarter and slowly move the reversing lever to the extreme forward position. The steam is thus admitted into the front end of the cylinder, and no blow out of the exhaust is heard. Then slowly move the reversing lever to the extreme backward position. No blow out of the exhaust proves that the right side is steam tight. Next place the left crank on the top quarter and move the reversing lever slowly to the extreme forward position. The steam is thus admitted into the back end of the cylinder. A blow out of the exhaust is heard, but stopped before one could locate the defect.

Place the reversing lever in the central position. No blow out of the exhaust or no steam pressure out of either cylinder cock prove that the left

valve is steam tight. Move the reversing lever slowly to the extreme backward position. When the steam was first admitted into the front end of the cylinder a blow was heard, but stopped before one could locate the defect. Then place the reversing lever forward again, until the valve opens the rear cylinder port a trifle. A blow out of the exhaust and a strong steam pressure out of the front cylinder cock indicate that the cylinder packing is blowing. Move the reversing lever two notches forward. There is a roar out of the exhaust and a strong steam pressure out of the front cylinder cock. Again move the reversing lever two notches forward, and the blow stops. This indicates that the cylinder packing is worn too small for the cylinder, and with only a little port opening, the volume of steam is not forceful enough to expand the rings to the cylinder; but after the port is half open or more,

then the steam pressure expands the rings to the cylinder and no blow is heard, proving that the left cylinder packing is defective.

TO LOCATE THE TURNED CYLINDER BUSHING.

If the engine becomes suddenly lame and there seems to be nothing wrong with the valve gear, place the right crank on the top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. The boiler pressure on the back cylinder cock indicates that the cylinder bushing is not turned. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. The boiler pressure on the front cylinder cock proves that the right cylinder bushing is not turned.

Next place the left crank on the top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. No steam pressure on the back cylinder cock indicates that

the cylinder bushing is turned. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. No steam pressure on the front or either cylinder cock proves that the left cylinder bushing has turned and closed the outlet to the cylinder drain cocks.

TO LOCATE CYLINDER POUNDS.

The piston head working to and fro on the piston rod will cause a very bad pound which can be located best by placing either crank on the top quarter and moving the reversing lever to and fro. When the steam is admitted into the front end of the cylinder no pound is heard, but when the steam is admitted into the back end of the cylinder a very sharp pound is heard, which sounds as though the pound is either at the front end of the main rod or at the main crank. Then listen to the cylinder when the steam is admitted into the back end. A ringing sound heard in the cylinder indicates that the piston head is loose on the piston rod.

The taper fit of the piston head on the piston rod, and the large nut that holds the head on the piston rod controls the sound of the piston head pound. This pound is heard only

when the steam is admitted into the back end of the cylinder.

Other cylinder pounds can be located best when the engine is running, by placing the hand or foot on the cylinder and feeling the jar to see if the pound is at one end or at both ends of the cylinder. The very slightest cylinder pound should be repaired.

TO LOCATE IF THE GUIDE BARS NEED CLOSING OR ARE BENT.

The back ends of the cross-heads always wear the most. For this reason, it should not be judged that the guides need closing from looking at the back end of the cross-head, when the cross-head is at the front end of the guides. If the front end of the cross-head is neatly fitted at the front end of the guides and the back end of the cross-head is neatly fitted at the back end of the guides, but the front end of the cross-head is an eighth of an inch or more loose in the middle of the guides, this proves that the guide or guide bars are bent and should be straightened.

TO LOCATE THE MAIN ROD AND MAIN BOX POUNDS.

Place either crank on the top quarter. Move the reversing lever to and fro and feel if the pound is in the

front end or in the back end of the main rod. Then feel if there is any pound in the main box or the main crown bearings. Do not judge from the sound, but feel the pound. Then the defect can be repaired.

TO LOCATE THE ENGINE OUT OF TRAM.

Place the engine on a straight and level track. Next place either side on the forward center and then on the back center. If the bushing or bushings are free on the pin or pins when on either center, it indicates that the engine is in tram. If the bushing or bushings are so tight on the pin or pins, when the engine is on either center, that they can not be moved by means of a pry, it proves that the driver or drivers, or the side rod or rods, are out of tram.

The badly worn side rod and knuckle pin bushings can also be located when the engine is in the above

mentioned positions, by lifting the side rods up and down on the pins. If the bushing or bushings lift up and down on the pin or pins an eighth of an inch or more, it indicates that the bushing or bushings are three-sixteenths of an inch larger than the pin or pins, and should be renewed.

TO LOCATE THE LOOSE WEDGES AND HOW TO ADJUST SAME.

Place the engine on a straight and level track, with the right crank on the top quarter and the reversing lever in the extreme backward position. Then place the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder. This forces the boxes tight against the shoes, which is the proper position to find if the wedge or wedges need adjusting.

If the wedge or wedges are loose, loosen the wedge bolt lock nut, screw

the wedge bolt up with one hand, and pry the wedge up with a small pin bar with the other hand, until the wedge sticks without dropping down. The wedge or wedges are then in the proper place.

Perform the same operation on the left side.

THE MALLET ENGINE.

The compound mallet engine admits the steam into both the high and low pressure engines direct from the boiler, with the intercepting valve in the simple position. The defects can then be located by using the same operations as for any other engine. For illustration, place the right crank of the low pressure engine on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. A roar out of the exhaust and no steam pressure out of the back cylinder cock, indicate that the right cylinder packing is steam tight.

Place the reversing lever in the central position. The same blow out of the exhaust and no steam pressure out of either cylinder cock, prove that the right valve is steam tight. Then place the reversing lever in the extreme

backward position. The steam is thus admitted into the back end of the cylinder.

The same blow out of the exhaust, but no steam pressure out of the front cylinder cock, prove that the right side is steam tight. Next place the left crank on the top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder.

The same roar out of the exhaust and a sharp steam pressure blows out of the front cylinder cock, indicate that the valve is blowing.

Place the reversing lever in the central position. The same blow out of the exhaust and a sharp steam pressure blows out of both cylinder cocks, prove that the left valve is blowing.

Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. The same blow out of the exhaust and a sharp steam

pressure blows out of the back cylinder cock, indicates that the left valve blows in all positions.

Next place the right crank of the high pressure engine, on the bottom quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the front end of the cylinder. A roar out of the exhaust and a very strong steam pressure out of the back cylinder cock, indicate that the right cylinder packing is blowing. Place the reversing lever in the central position. No roar out of the exhaust and no steam pressure out of either cylinder cock, prove that the right valve is steam tight. But there is a sharp blow out of the exhaust which comes from the left low pressure engine valve. Then place the reversing lever in the extreme backward position. The steam is thus admitted into the back end of the cylinder.

A roar out of the exhaust and a

strong steam pressure out of the front cylinder cock, prove that the right high pressure engine cylinder packing is blowing.

Next place the left crank of the high pressure engine, on the top quarter and the reversing lever in the extreme forward position. The steam is thus admitted into the back end of the cylinder.

A roar out of the exhaust, but no steam pressure out of the front cylinder cock, indicate that the left side is steam tight.

Place the reversing lever in the central position. The same roar out of the exhaust, but no steam pressure out of either cylinder cock, prove that the left valve is steam tight.

Then place the reversing lever in the extreme backward position. The steam is thus admitted into the front end of the cylinder. The same roar out of the exhaust and no steam pressure out of the back cylinder cock,

prove that the left side of the high pressure engine is steam tight. Also proves, that the right high pressure cylinder packing and the left low pressure valve, are blowing.

DON'TS.

Don't report both valves examined when only one side is defective.

Don't report both cylinder packing when only one side is defective.

Don't report the piston or valve stem packed when it is only the gland joint leaking.

Don't report the brasses at the front end of the main rods filed when the pound is in the back end.

Don't report the brasses filed at the back end of the main rods when the pound is in the main driving boxes.

Don't report all of the side rod bushings renewed when only one or two of them are pounding.

Don't report all of the knuckle pin bushings renewed when only the back ones are pounding.

Don't examine the piston valve packing rings without examining the steam chest bushings for defects.

Don't pack the piston or the valve stem without examining same to see if in fit condition to be packed.

Don't close the guides from the top when they need closing from the bottom.

Don't key up the brasses at the front end of the main rod when the crank is on either center.

Don't file the brasses open at the back end of the main rods.

Don't use three or four thin liners in lining brasses or guides when one solid liner can be used.

Don't close the guides without seeing that the guide oil cups are in perfect working condition.

Don't use short rush iron liners in resetting the driving tires.

Don't fail to see that the tire or tires are set at the proper place.

Don't adjust the wedges only when the engine comes in from a run; the boxes are then expanded.

Don't connect up the main rods without dividing the clearance in the cylinders.

